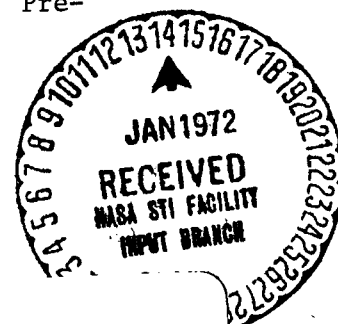


THE STUDY AND CALIBRATION OF PRESSURE TRANSDUCERS
IN PARTICULAR ENVIRONMENTS

B. Baërd, A. Julienne and R. Nantois

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THE STUDY AND CALIBRATION OF PRESSURE TRANSDUCERS IN PARTICULAR ENVIRONMENTS

B. Baërd, A. Julienne and R. Nantois

ABSTRACT. The design concepts and calibration of unsteady pressure transducers are described. These transducers must operate under difficult conditions, such as at high pressure levels, high flow rates, high static overpressures, high vibration rates, and high temperatures. These studies were carried out in connection with the study of noise having aerodynamic origin.

/757-1*

1. INTRODUCTION

The O.N.E.R.A. has studied several types of unsteady pressure transducers intended for model measurements. These are measurements in the interior of turbomachines, measurements in the interior of jets, and on exhaust nozzles.

The tests were carried out at the O.N.E.R.A. and at the S.N.E.C.M.A./Melun Villaroche).

2. MEASUREMENTS OF PRESSURE FLUCTUATIONS IN THE INTERIOR OF TURBOMACHINES

2.1. Required Transducer Characteristics

These consist of: reduced dimensions, insensitivity to vibrations, simple concept and modest price.

* Numbers in the margin indicate pagination in the original foreign text.

2.2. Description of the Transducers

The transducer is of the capacitive type and uses the electret effect [1]. Its study was based on the work of Sessler and West [2, 3]. The impedance adapter is integrated into the transducer housing.

Several models have been conceived:

- a so-called "long" model: a cylinder having a diameter of 7 mm, intended for measurements of characteristics of acoustic modes in compressor channels [4, 5];

- two so-called "flat" models: disks having a diameter of 7 mm, thickness 2.5 mm and also 5 mm and 1.7 mm, respectively; they are designed for installation in the thick part of turbomachine blades. /757-2

2.3. Measurements Carried out with the Transducers (Calibration)

The procedures used take into account existing methods [6]. The results show the following:

- a higher sensitivity (example: 100 mV/134 dB), but a favorable signal/noise ratio beginning with 100 dB;

- a very extensive response curve (Figure 1);

- a very small sensitivity with respect to vibrations (Figure 2); the deviations between the theory and the experimental points are related to the presence of the air mass which is set into motion by the membrane, (mylar 13 μ).

- a variation in sensitivity (deviation 0 to 20 dB) due to static pressure (\pm 100 mbar) which is superimposed on the acoustic pressure. It is

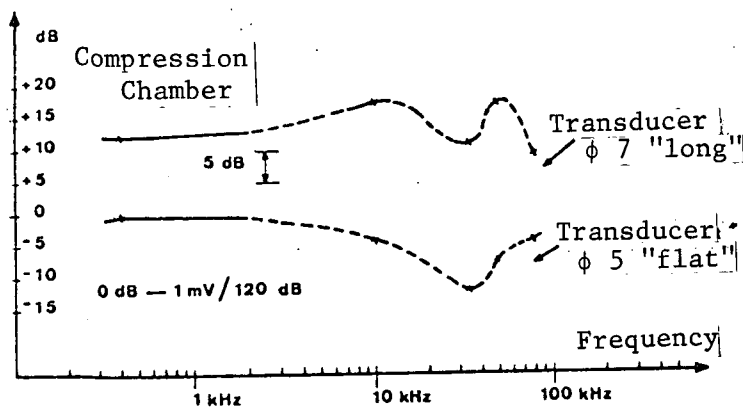


Figure 1. Response curves of electret transducers measured with the ionophone.

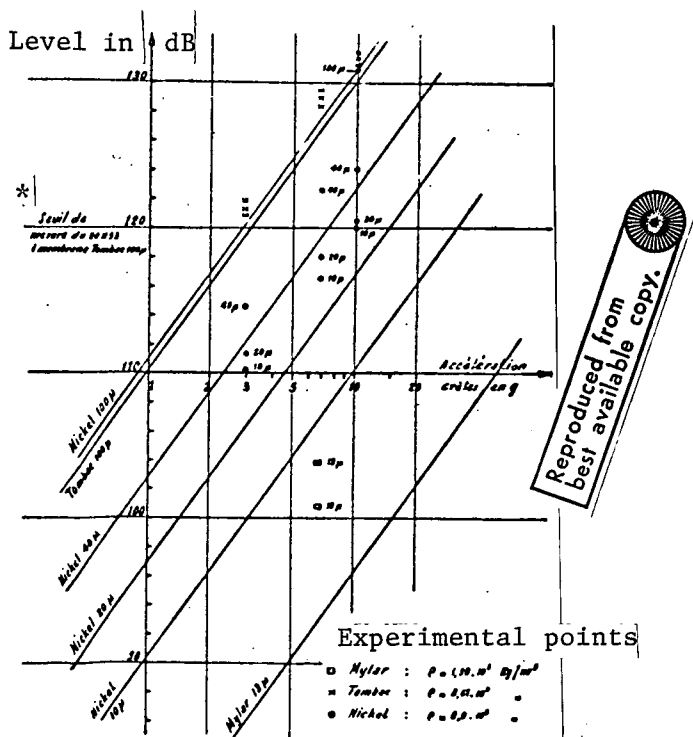


Figure 2. Vibration sensitivity of membrane transducers.

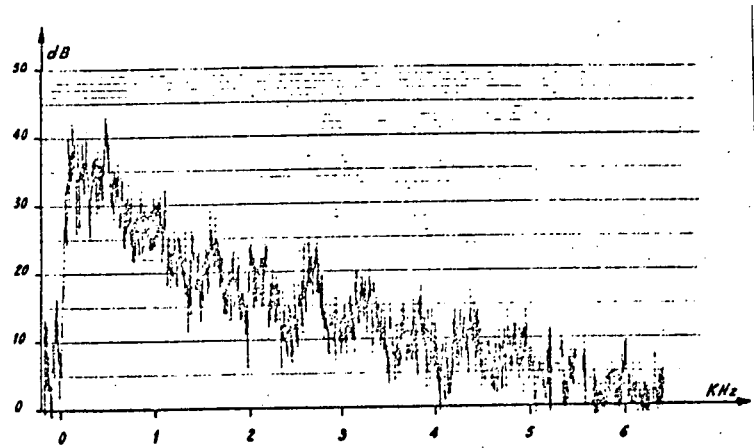
*Translator's Note: Illegible in foreign text.

a function of the air which escapes between the membrane and the electrode,

- if there is an /757-3 air flow, the hemispherical grille having a fine mesh will improve the signal/noise ratio (Figure 3: without grille — Figure 4: with grille). For a slow flow ($Mo \approx 0.08$), the grille is effective for frequencies above 1.5 KHz. For a moderate flow, the discrete frequencies dominate the continuous noise in a very clear way. The probe supports do not affect the sonic field downstream from the measurement conduit.

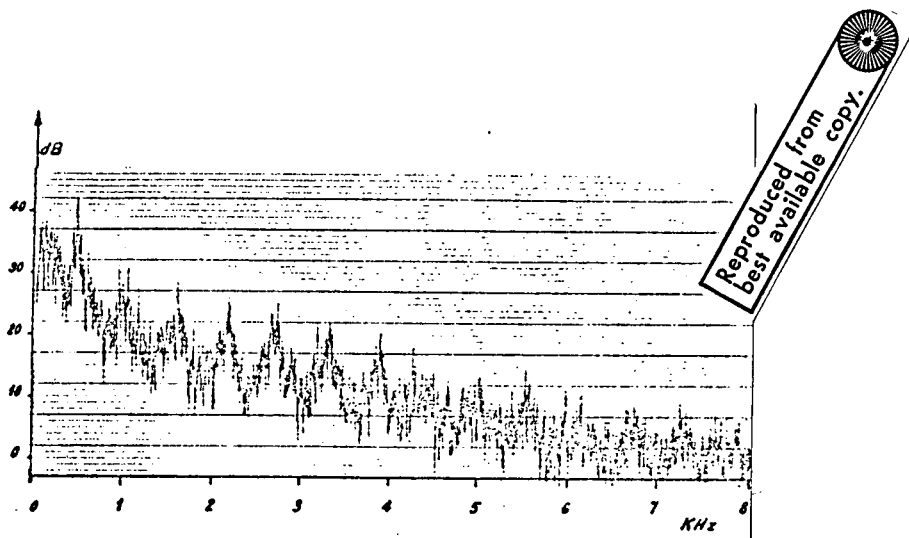
3. MEASUREMENT OF PRESSURE FLUCTUATIONS IN THE INTERIOR OF JETS

The operating conditions are the following: Sonic levels of 160 dB, static overpressure of two bars, a Mach 0.3 flow and temperature rise of 450°C .



Transducer No. 7. Bottom position without grille (2a).

Figure 3. Noise spectrum of a ventilator: transducer alone.



Transducer No. 7. Bottom position with grille (2b).

Figure 4. Noise spectrum of a ventilator: transducer protected by a hemispherical grille.

The transducer tested has a diameter of 7 mm and has exterior polarization.

The signal can no longer be evaluated after 450° C; after it returns to ambient conditions, it functions in a normal manner. Consequently, the

transducer components resist the thermal effects. The form of the response curve does not vary in a significant way with temperature.

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